REMARKS

In view of the remarks submitted below, Applicants request reconsideration of the rejections of Claims 9-12 and 16-20 and the objection to Claims 13-15 of the above-named reissue application. Claims 1-8 have been allowed.

Rejection of Claims 9-12 and 16-20 under 35 U.S.C. 251

Claims 9-12 and 16-20 have been rejected under 35 U.S.C. 251 as being improperly broadened in a reissue application made and sworn to by the assignee and not the patentee. The application was in fact made and sworn to by the patentee, i.e., the inventors, when the application was filed on September 23, 2003. Copies of the pertinent papers to support this fact are submitted in the following Exhibits:

Exhibit A is a copy of Form PTO/SB/51 (Reissue Application Declaration by the Inventor) as executed by inventors Mark Julian Roberts and Rakesh Agrawal on September 22, 2003 and filed with the above-identified reissue application on September 23, 2003.

Exhibit B is a copy of the Reissue Patent Application Transmittal Form indicating that the Reissue Oath/Declaration (Application Element 5) was filed with the application.

Exhibit C includes copies of (1) the back of the return receipt postcard submitted with the reissue application, addressed to the assignee, and returned by mail by the USPTO to the assignee, which shows that Form PTO/SB/51 was included with the application and (2) the front of the postcard with the USPTO confirmation of the date of filing and the serial number of the application.

In view of these Exhibits confirming that the application was in fact made and sworn to by the patentee, the Examiner is requested to withdraw the rejection of Claims 9-12 and 16-20 under 35 U.S.C. 251.

Rejection of Claims 9-12, 16-18, and 20 under 35 U.S.C. 102(b)

Claims 9-12, 16-18, and 20 have been rejected under 35 U.S.C. 102(b) as anticipated by U.S. Patent 4,334,902 to H. Paradowski ("Paradowski").

Paradowski discloses a process and apparatus for saving energy in a method of liquefying natural gas by cooling the natural gas in a heat exchanger with one or two vaporizing refrigerants provided in a low-temperature closed-loop refrigeration system. In other embodiments, a second closed-loop refrigeration system is used to cool the compressed refrigerant in the low-temperature closed-loop refrigeration system.

In one embodiment (Fig. 1), the refrigerant for vaporization (20, 21) is provided by (a) compressing a gaseous refrigerant (12a, 12b), (b) cooling the compressed refrigerant by ambient cooling (15) and by propane or propylene refrigeration (16) to partially or totally condense the refrigerant, (c) further cooling and subcooling (17) the refrigerant in the heat exchanger (3) while cooling the natural gas (4) therein, and (d) reducing the pressure of the subcooled liquid refrigerant (18) in a hydraulic expansion turbine (19) to provide the vaporizing refrigerant.

In another embodiment (Fig. 2), two refrigerants (20a, 20b) are provided for vaporization, each having a different composition based on phase separation (26) after compression (12a, 12b) and partial condensation (25, 16). The liquid (14b) after phase separation is subcooled (17b) and expanded in a hydraulic expansion turbine (19b) to provide the first refrigerant (20b) for vaporization. The vapor (14a) is condensed, subcooled (17a), and expanded in a hydraulic expansion turbine (19a) to provide the second refrigerant (20a) for vaporization.

In another embodiment (Fig. 3), an additional closed-loop refrigeration system (III) provides for condensation (31) in another heat exchanger (16') of the compressed refrigerant (14) of Fig. 2. This additional closed-loop refrigeration system (III) provides a refrigerant for vaporization in the heat exchanger (16') by expanding a pressurized, subcooled liquid refrigerant (43) in a hydraulic expansion turbine (44).

In yet another embodiment (Fig. 4), an additional refrigerant stream (59) for vaporization to cool the feed natural gas (28) in an additional heat exchanger (27) is provided in the refrigeration system (II) by another phase separation step (51). The liquid (52) from this step is subcooled (53) and expanded in another hydraulic expansion turbine (55). In the additional refrigeration system (III) that cools the compressed refrigerant in the refrigeration system (II), the heat exchanger (16') is split into two heat exchangers (16'a, 16'b). Another subcooled liquid refrigerant stream (43) is withdrawn between the exchangers (16'a, 16'b)

and expanded in a hydraulic expansion turbine (44a) to provide a liquid refrigerant for vaporization in heat exchanger 16'a. The remaining subcooled liquid refrigerant (37') is further cooled (42b) in heat exchanger 16'b and is expanded in hydraulic expansion turbine 44b to provide refrigerant for vaporization in heat exchanger 16'b.

In a final embodiment (Fig. 5), the refrigeration system (II) of Fig. 2 is modified to provide two additional refrigerants (81, 90) for vaporization in an additional heat exchanger (73) to precool the refrigerant (89) prior to phase separation (26), subcooling (17a, 17b), and expansion in hydraulic expansion turbines 19a and 19 b earlier described. In the modification, additional phase separation steps (69, 51') provide liquid refrigerants (77, 86) that are subcooled (75, 88) in the additional heat exchanger (73) to provide subcooled refrigerants (78, 90) that are expanded in hydraulic expansion turbines 79 and 91 to provide refrigerants (83, 93) for vaporization in the additional heat exchanger (73).

In all of Paradowski's embodiments of Figs. 1-5 as summarized above, <u>subcooled liquid refrigerants</u> are expanded in hydraulic expansion turbines to provide refrigerant streams for subsequent vaporization in the various heat exchangers.

The embodiments as claimed in Claims 9-12, 16-18, and 20 comprise a method and apparatus for the liquefaction of a feed gas wherein at least a portion of the refrigeration required to cool and condense the feed gas is provided by a first refrigeration system utilizing two or more refrigerant components to provide refrigeration in a first temperature range and a second refrigeration system to provide refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream. At least a portion of the pressurized gaseous refrigerant stream prior to work expansion is cooled by heat exchange means entirely separately from the cooling of the feed gas.

The claimed embodiments differ from the disclosure of Paradowski because the claimed embodiments utilize the work expansion of a <u>pressurized gaseous refrigerant</u> to provide a portion of the refrigeration required for gas liquefaction.

Claim 9, step (b) specifically recites

> "(b) a second refrigeration system which provides refrigeration in a second temperature range by work expanding <u>a pressurized gaseous refrigerant</u> stream."

Claim 9, step (3) specifically recites

> "(3) work expanding the cooled gaseous refrigerant to provide the cold refrigerant in (b)."

Claim 16 recites

> "(3) expansion means for work expanding the cooled gaseous refrigerant to provide the cold refrigerant."

In contrast, Paradowski expands subcooled liquid refrigerants in hydraulic expansion turbines in all disclosed embodiments to provide cooled reduced-pressure liquid refrigerant for subsequent vaporization. All expansion turbines in the embodiments of Figs. 1-5 expand subcooled liquids. No gaseous refrigerant is expanded in any of Paradowski's expanders. Applicants submit that work expansion of a gaseous refrigerant as claimed is fundamentally different than the expansion of a subcooled liquid refrigerant as disclosed by Paradowski.

Because the claimed embodiments are not identically disclosed by Paradowski, the claimed embodiments are not anticipated by Paradowski. The rejection of Claims 9-12, 16-18, and 20 under 35 U.S.C. 102(b) as anticipated by Paradowski is improper, and the Examiner is requested to withdraw this rejection.

Rejection of Claims 9, 10, 12, and 16-20 under 35 U.S.C. 103(a)

Claims 9, 10, 12, and 16-20 under 35 U.S.C. 103(a) have been rejected as being unpatentable over U.S. Patent 4,755,200 to Y. Liu et al. ("Liu") in view of U.S. Patent 5,768,912 to C. A. Dubar ("Dubar").

Liu discloses a propane-precooled dual mixed refrigerant system and process for the liquefaction of natural gas. The feed gas is precooled by vaporizing propane refrigerant and further cooled and liquefied in a main heat exchanger by vaporizing low-level liquid mixed refrigerant streams. The low-level liquid refrigerant is provided by compressing vaporized low-level refrigerant, cooling and partially condensing the compressed low-level refrigerant by vaporizing propane refrigerant and by vaporizing liquid high-level refrigerant provided by a separate refrigeration loops. The liquid fraction of the low-level refrigerant is subcooled in the main heat exchanger and reduced in pressure to provide a portion of the vaporizing low-level liquid mixed refrigerant. The vapor fraction of the low-level refrigerant is condensed and subcooled in the main heat exchanger and reduced in pressure to provide another

portion of the vaporizing low-level liquid mixed refrigerant. Liu is silent regarding refrigeration by work expansion of pressurized gaseous refrigerants.

Dubar discloses a process and apparatus for liquefying natural gas with refrigeration provided by a modified nitrogen expander cycle with optional supplemental refrigeration provided by a propane, Freon, or ammonia absorption refrigeration system (114). The nitrogen expander cycle is a split cycle in which a compressed gaseous nitrogen refrigerant (28 in Fig. 4; 33 in Figs. 5 and 6) is cooled, divided, and work expanded (106, 107 in Fig. 4; 106, 107, 108 in Figs. 5 and 6) at multiple temperature levels to provide cooling of the feed (2) and the compressed nitrogen refrigerant in multiple heat exchange zones (100, 101, 102, 103 in Fig. 4; additionally 104 in Figs. 5 and 6). Optionally, additional refrigeration (114, Figs. 5 and 6) is provided in warm heat exchanger 100. Dubar discusses in detail various advantages of the nitrogen expander cycle over conventional mixed refrigeration cycles (see column 3, lines 28-67 and column 15, lines 15-27).

The embodiments of Claims 9, 10, 12, and 16-20 comprise a method and apparatus for the liquefaction of a feed gas wherein at least a portion of the refrigeration required to cool and condense the feed gas is provided by a first refrigeration system utilizing two or more refrigerant components (i.e., mixed refrigerant) to provide refrigeration in a first temperature range and a second refrigeration system to provide refrigeration in a second temperature range by work expanding a pressurized gaseous refrigerant stream. At least a portion of the pressurized gaseous refrigerant stream prior to work expansion is cooled by heat exchange means entirely separately from the cooling of the feed gas.

The claimed embodiments differ from Liu because Liu provides all refrigeration for the gas liquefaction process by the vaporization of pure component and mixed refrigerants. In contrast, the claimed embodiments provide a portion of the refrigeration by vaporizing mixed refrigerants and provide another portion of the refrigeration by the work expansion of a pressurized gaseous refrigerant.

The claimed embodiments differ from Dubar because Dubar provides all refrigeration for the gas liquefaction process by the work expansion of a pressurized gaseous refrigerant optionally supplemented by vaporization of propane or freon refrigerants or by ammonia absorption refrigeration. In contrast, the claimed embodiments provide a portion of the

refrigeration by vaporizing mixed refrigerants and provide another portion of the refrigeration by the work expansion of a pressurized gaseous refrigerant.

Dubar teaches away from the claimed embodiments by providing an extensive discussion of the disadvantages of mixed refrigeration systems (see column 3, lines 28-67 and column 15, lines 15-27). Dubar states at column 15, lines 15-27 that

> "Advantages of the present invention include that split nitrogen expander cycle operates entirely in the single phase gas region which allows for the elimination of all compressor suction drums, phase separators and refrigerant accumulators required in the mixed refrigerant process. The single phase of the refrigerant eliminates the flow distribution problems associated with two phase flow in heat exchanger devices and allows the use of conventional plate fin heat exchangers without the associated phase separators and distribution systems normally required or offers and alternative to the highly specialized and expensive spiral wound heat exchangers conventionally used in mixed refrigerant process plants."

This explanation (as well as that of column 3, lines 28-67) would clearly direct a person skilled in the art of gas liquefaction to utilize Dubar's system instead of a mixed refrigeration system. Dubar's teaching would direct the skilled person to consider gaseous work expander refrigeration as an alternative to, rather than a process to be combined with, mixed refrigerants. Dubar thus is a defective reference for use in judging the patentability of the claimed embodiments.

The skilled person would have no motivation to combine the disclosures of Liu and Dubar because Liu is completely silent regarding refrigeration by work expansion of gaseous refrigerants, and specifically requires the use of mixed refrigerant systems. Dubar, on the other hand, teaches that gas expander refrigeration is required and that mixed refrigerant systems have many disadvantages. The diametrically-opposed and contrary teachings of Liu and Dubar would not motivate the skilled person to combine a work expansion refrigeration process and a mixed refrigerant process as claimed.

Regarding Claim 20, the Examiner suggests that spiral wound heat exchangers are well-known in the cooling art and would have been an obvious modification for an ordinary practitioner in the art. In view of the contrary teachings of Dubar cited above, Applicants disagree that the claimed use of spiral wound heat exchangers in a combined process using mixed refrigerants and gas expanders is an obvious modification.

For these reasons, Applicants respectfully submit that the Examiner has not established a clear case of obviousness in rejecting Claims 9, 10, 12, and 16-20 under 35 U.S.C. 103(a) as being unpatentable over Liu in view of Dubar, and they request that the rejection be withdrawn.

Objection to Claims 13-15

Claims 13-15 were objected to as being dependent upon a rejected base claim. This objection is improper because Claim 13 is an independent claim. In a telephone discussion of this issue on August 17, 2005 between the Examiner and John M. Fernbacher, agent of record, the Examiner advised that these claims are allowed. It is therefore requested that allowance be confirmed and the objection be withdrawn.

Summary

In view of the arguments presented above, Applicants request withdrawal of the rejection of Claims 9-12 and 16-20 under 35 U.S.C. 251, the rejection of Claims 9-12, 16-18, and 20 under 35 U.S.C. 102(b), and the rejection of Claims 9, 10, 12, and 16-20 under 35 U.S.C. 103(a). The objection to Claims 13-15 should be withdrawn. A timely Notice of Allowance for Claims 1-20 is requested.

Respectfully submitted,

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